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SHORT AND SWEET

Neanderthal paintings? Production of prototypical human (*Homo sapiens*) faces shows systematic distortions

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Abstract. People's sketches of human faces seem to be systematically distorted: the eye position is always higher than in reality. This bias was experimentally analyzed by a series of experiments varying drawing conditions. Participants either drew prototypical faces from memory (studies 1 and 2: free reconstruction; study 3: cued reconstruction) or directly copied average faces (study 4). Participants consistently showed this positioning bias, which is even in accord with facial depictions published in influential research articles by famous face researchers (study 5). We discuss plausible explanations for this reliable and stable bias, which is coincidentally similar to the morphology of Neanderthals.

Keywords: face processing, bias, configural processing, imagery, recall, configuration, Neanderthals

Let's start with a small task. Please draw a prototypical face in the empty box of figure 1, just with its essential aspects, ie outline, eyes, etc!

Figure 1. Please draw a prototypical face in this box!

Now, please compare your sketch with the schematized depiction of a human face shown in figure 2, based on average craniometric data (Farkas, Hreczko, & Katic, 1994). Do you notice any striking differences? Are the eyes in your sketch at a considerably higher position than in the sketch of figure 2? If you respond towards the mean of most people, this is probably the case. However, our studies show that the distorted configurations of your sketch do not reflect a lack of artistic talent, but a bias in the production of facial prototypes most people concordantly show.

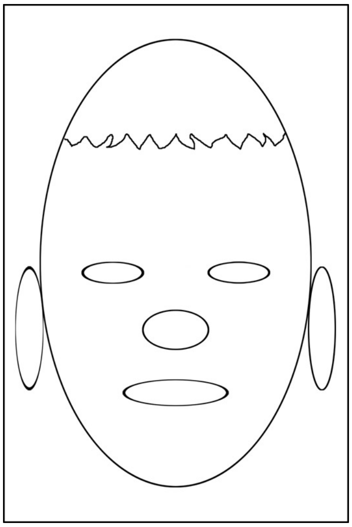

Figure 2. Schematized depiction of an average human face based on craniometric data (Farkas et al., 1994).

In order to draw a human face, we need to recall a representation of a typical instance, a ‘prototype’, of the class ‘human faces’. Prototypes are usually defined as results of principal components (Basri, 1996) or as averages of all encountered exemplars of a class (Burton, Jenkins, Hancock, & White, 2005). Both approaches cannot really explain why producing prototypes of such a frequently encountered object class should yield systematically distorted results.

Here, we try to investigate the conditions and the reliability of this effect under different drawing conditions. The methods of our different studies are summarized in table 1.

Table 1. Method specifications of our studies.

Study number	Study title	*N*	Procedure
1	free reconstruction of faces (sheet on a desk)	41	drawing the prototype of a face on a blank A4 piece of paper located on a desk
2	free reconstruction of faces (sheet on the wall)	38	drawing the prototype of a face on a blank A4 piece of paper located on the wall at eye level to avoid artificial effects based on perspective distortion
3	cued reconstruction of faces	106	two average faces (female and male) presented to the participants for 30 s; task: depicting these faces from memory
4	copying of faces	21	copying two average faces (female and male)
5	highly cited face depictions	3	measurement of faces appearing in influential face research articles (Bruce & Young, 1986; Ellis & Lewis, 2001; Gobbini & Haxby, 2007)

Depicted faces in all studies showed systematic distortions regarding the position of the eyes: eyes were consistently located at higher positions than in average faces (figure 3). We statistically test these deviations by using the ratio of the distance between the *endocanthion* (tear duct) level and the *gnathion* (tip of the chin) divided by the distance between the *vertex* (highest point of the head) and the gnathion. This measure was then compared with the average eye position ratio determined in craniometric studies (ie 0.477; see Farkas et al., 1994) using two-tailed one-sample *t*-tests. In those studies, using average faces as models (studies 3 and 4), the average eye position ratio of the drawings was compared with the eye position ratios of the model faces (0.488 for male and 0.473 for female faces). Table 2 summarizes the results of the inferential analyses.

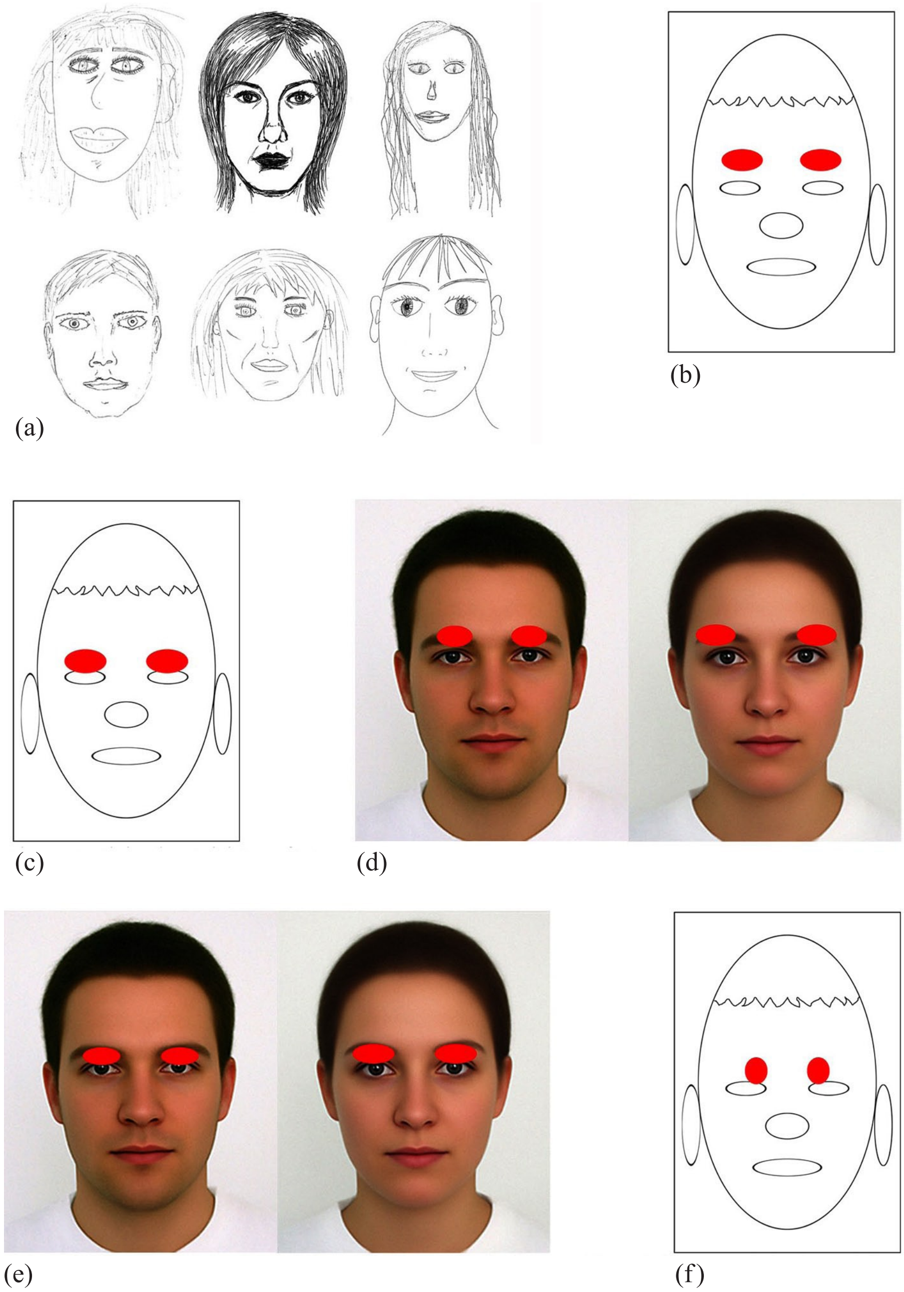

Figure 3. [In colour online, see http://dx.doi.org/10.1068/p7604] Illustrations of averaged results. (a) Examples for sketches from study 1. (b) Relative empirical position of the eyes derived from study 1 superimposed on a sketch based on craniometric data (Farkas et al., 1994). (c) Relative empirical position of the eyes derived from study 2 superimposed on a sketch based on craniometric data (Farkas et al., 1994). (d) Relative empirical position of the eyes derived from study 3 superimposed on the model faces (average faces stem from Gründl, 2013, reproduced with permission of the author). (e) Relative empirical position of the eyes derived from study 4 superimposed on the model faces (average faces stem from Gründl, 2013, reproduced with permission of the author). (f) Relative empirical position of the eyes derived from study 5 superimposed on a sketch based on craniometric data (Farkas et al., 1994).

Table 2. Summarized results.

Study number	Mean eye position ratio (SD)	Mean deviation from average face	T_{df}	p	Effect size/d
1	0.570 (0.073)	0.093	$T_{40} = 8.1$	< 0.001	1.27
2	0.531 (0.115)	0.054	$T_{37} = 2.9$	< 0.01	0.47
3 (male)	0.565 (0.062)	0.077	$T_{105} = 12.8$	< 0.001	1.25
3 (female)	0.564 (0.068)	0.091	$T_{105} = 13.9$	< 0.001	1.35
4 (male)	0.538 (0.044)	0.050	$T_{20} = 5.2$	< 0.001	1.13
4 (female)	0.536 (0.046)	0.048	$T_{20} = 4.7$	< 0.001	1.03
5	0.539 (0.020)	0.062	$T_2 = 4.7$ ($Z = 3.1$)	< 0.05	3.15

The results of our studies show that most people—even famous face researchers (study 5)—are susceptible to the mentioned bias, and thus produce distorted depictions of faces. Several explanations for these distortions seem plausible, as follows. (1) 'Hair as hat' hypothesis: people do not account for the area of the hair as part of the head, but as a kind of 'hat', thus mentally locating the eyes towards the top of the face. (2) 'Head as box' hypothesis: The convexity of the forehead is not taken into account, so the top of the head is identified as being lower. (3) 'Face from below' hypothesis: babies' first visual experiences of faces are made by an extreme perspective from bottom up, affecting mental representations (for a more extensive discussion of this hypothesis see Wirth & Carbon, 2010). Follow-up analyses revealed that the relative length of the depicted faces in studies 1–4 is significantly reduced compared with the average (model) face(s) (Ts < -2.2, ps < 0.05), whereas the hairline is in a proper relative position ($0 > T$s > -1.8, ps > 0.05) causing a reduced height of the forehead. This rather supports the 'head as box' hypothesis rather than the 'hair as hat' hypothesis'. Owing to their low foreheads, participants' depictions are incidentally similar to the morphology of Neanderthals (Thompson & Illerhaus, 1998), our sister species—which, we thought, became extinct about 30 000 years ago (Harvati, 2010). However, as long as our production of faces is distorted so clearly, Neanderthals live on, at least in our depictions.

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